TESTS FOR ALLELISM AMONG CERTAIN LARVAL COLOR MUTANTS OF *CULEX QUINQUEFASCIATUS*

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ABSTRACT. A number of interesting larval mutants have been found in natural populations of *Culex quinquefasciatus*. These mutants golden yellow (*go*), greyish brown (*gb*), brown (*br*) and green (*g*) are all autosomal recessives with full penetrance and high viability in both the sexes. Crosses were made among these mutants to test for allelism. The mutant green was found to be dominant over brown, greyish brown and golden yellow. Brown was dominant over golden yellow and greyish brown. These color mutants appear to belong to an allelic series. Greyish brown and golden yellow appear to be allelic, with intermediate expression in the heterozygotes condition. The fact that all the 4 mutants apparently belong to an allelic series is perhaps expected but these experimental results provide, for the first time, direct support for this assumption.

A number of interesting larval mutants have been found in natural populations of *Culex quinquefasciatus* Say-*fatigans* Wiedemann, an important vector of filaria in Southeast Asia (Shetty 1974). These mutants, golden yellow (*go*), greyish brown (*gb*), brown (*br*) and green (*g*), are all autosomal recessives with full penetrance and high viability in both the sexes. Tests for allelism were made among these mutants and the results are reported here.

MATERIALS AND METHODS. The mutants *go, br, gb* and *g* were maintained separately in a routine fashion. In all crosses 5 females and 5 males were placed in an 8x8x8 inches cage made of an iron frame covered with nylon net with a water-soaked sponge and a 10% sugar pad. The males and females used in the experiments were all originally isolated as single pupae in vials, then sexed before they were introduced into the experimental cage.

RESULTS. Crosses were made among these mutants to study interactions among them. Mass matings were made between mutant types and appropriate reciprocal crosses were also made. Some of the F_1 hybrids were inbred to obtain the F_2 generations and others were back-crossed to the parental mutant type.

Results of crosses between the mutants

Table 1. Mode of inheritance of green (*g*) and brown (*br*) larval color.

Cross No.	Cross	No. of larvae			x^2
		Green	Brown	Total	
1.	Green ♀ x brown ♂	275	..	275	..
2.	Green ♂ x brown ♀	198	..	198	..
3.	Brown ♂ x F_1♀ (green ♀ x brown ♂)	419	449	868	1.037*
4.	Brown ♀ x F_1♂ (green ♀ x brown ♂)	314	337	651	0.813*
5.	F_1♂ (green ♀ x brown ♂) x F_1♀ (green ♀ x brown ♂)	693	226	919	0.050*
6.	F_1♂ (green ♂ x brown ♀) x F_1♀ (green ♂ x brown ♀)	604	196	800	0.107*

* Not significant.

green and brown larvae have been summarized in Table 1. The F_1 larvae were all green in color, indicating that green was dominant over brown. The F_1 adults were back-crossed to brown of both sexes. Crosses 3 and 4 fit the expected 1:1 ratio between green and brown larvae. The F_1 adults were inbred to obtain the F_2 generations. Data from crosses 5 and 6 (Table 1) fit the expected 3:1 ratio of green and brown larvae.

The results of the crosses 1 and 2 between the mutants green and greyish brown have been summarized in Table 2. When mutants green and greyish brown were crossed, the F_1 larvae were all green in color, indicating that green was dominant over greyish brown. Back-crosses 3 and 4 fit the expected 1:1 ratio between green and greyish brown larvae. The results of crosses 5 and 6 involving inbreeding of the F_1 adults (Table 2) fit the expected 3:1 ratio of green and greyish brown larvae.

Crosses between brown and golden yellow scored in the 4th larval instar have been given in Table 3. In crosses 1 and 2 all the resulting F_1 larvae were all brown in color indicating that golden yellow is recessive. The results of the back-crosses 3 and 4 fit the expected 1:1 ratio between brown and golden yellow larvae and the crosses 5 and 6 involving inbreeding of F_1 adults (Table 3) fit the expected 3:1 ratio between brown and golden yellow larvae.

Results of crosses between green and golden yellow are given in Table 4. In crosses 1 and 2 all the resulting F_1 larvae were pure green in color. The dominance of green was found to be complete in the above crosses. The back-crosses 3 and 4 resulted in a 1:1 ratio between green and golden yellow larvae. In crosses 5 and 6 green and golden yellow segregated in a 3:1 ratio.

Crosses were also made between the mutants, brown and greyish brown. Data from crosses 1 and 2 (Table 5) showed that brown was dominant over greyish brown. Back-crosses 3 and 4 fit the expected 1:1 ratio between brown and grey-

Table 2. Mode of inheritance of green (*g*) and greyish brown (*gb*) larval color.

Cross No.	Cross	No. of larvae: Green	No. of larvae: Greyish Brown	No. of larvae: Total	x^2
1.	Green ♀ x greyish brown ♂	219	..	219	..
2.	Green ♂ x greyish brown ♀	167	..	167	..
3.	Greyish brown ♂ x F_1♀ (green ♀ x greyish brown ♂)	719	697	1416	0.342*
4.	Greyish brown ♀ x F_1♂ (green ♀ x greyish brown ♂)	804	793	1597	0.076*
5.	F_1♂ (green ♀ x greyish brown ♂) x F_1♀ (green ♀ x greyish brown ♂)	666	216	882	0.122*
6.	F_1♂ (green ♂ x greyish brown ♀) x F_1♀ (green ♂ x greyish brown ♀)	900	311	1211	0.337*

* Not significant.

Table 3. Mode of inheritance of brown (*br*) and golden yellow (*go*) larval color.

Cross No.	Cross	No. of larvae: Brown	No. of larvae: Golden Yellow	No. of larvae: Total	x^2
1.	Golden yellow ♀ x brown ♂	216	..	216	..
2.	Golden yellow ♂ x brown ♀	233	..	233	..
3.	Golden yellow ♀ x F_1♂ (golden yellow ♀ x brown ♂)	111	102	213	0.380*
4.	Golden yellow ♂ x F_1♀ (golden yellow ♀ x brown ♂)	154	163	317	0.256*
5.	F_1♂ (golden yellow ♀ x brown ♂) x F_1♀ (golden yellow ♀ x brown ♂)	612	207	819	0.033*
6.	F_1♂ (golden yellow ♂ x brown ♀) x F_1♀ (golden yellow ♂ x brown ♀)	719	247	966	0.168*

* Not significant.

Table 4. Mode of inheritance of green (*g*) and golden yellow (*go*) larval color.

Cross No.	Cross	No. of larvae: Green	No. of larvae: Golden Yellow	Total	x^2
1.	Green ♀ x golden yellow ♂	319	..	319	..
2.	Green ♂ x golden yellow ♀	297	..	297	..
3.	Golden yellow ♂ x F_1♀ (green ♀ x golden yellow ♂)	596	619	1215	0.435*
4.	Golden yellow ♀ x F_1♂ (green ♀ x golden yellow ♂)	429	438	867	0.934*
5.	F_1♂ (green ♀ x golden yellow ♂) x F_1♀ (green ♀ x golden yellow ♂)	1043	331	1374	0.607*
6.	F_1♂ (green ♂ x golden yellow ♀) x F_1♀ (green ♂ x golden yellow ♀)	1036	330	1366	0.516*

* Not significant.

Table 5. Mode of inheritance of brown (*br*) and greyish brown (*gb*) larval color.

Cross No.	Cross	No. of larvae: Brown	No. of larvae: Greyish Brown	Total	x^2
1.	Brown ♀ x greyish brown ♂	168	..	168	..
2.	Brown ♂ x greyish brown ♀	193	..	193	..
3.	Greyish brown ♂ x F_1♀ (brown ♀ x greyish brown ♂)	273	276	549	0.016*
4.	Greyish brown ♀ x F_1♂ (brown ♀ x greyish brown ♂)	159	166	325	0.151*
5.	F_1♂ (brown ♀ x greyish brown ♂) x F_1♀ (brown ♀ x greyish brown ♂)	165	61	226	0.048*
6.	F_1♂ (brown ♂ x greyish brown ♀) x F_1♀ (brown ♂ x greyish brown ♀)	267	85	352	0.136*

* Not significant.

Table 6. Mode of inheritance of greyish brown (*gb*) and golden yellow (*go*).

Cross No.	Cross	No. of larvae: Greyish Brown	Golden Yellow	Dark Brown	Total	x^2
1.	Greyish brown ♀ x golden yellow ♂	..	..	163	163	..
2.	Greyish brown ♂ x golden yellow ♀	..	..	206	206	..
3.	F_1♂ (greyish brown ♀ x golden yellow ♂) x F_1♀ (greyish brown ♀ x golden yellow ♂)	*107*	*104*	*221*	432	0.274*
4.	F_1♂ (greyish brown ♂ x golden yellow ♀) x F_1♀ (greyish brown ♂ x golden yellow ♀)	*213*	*206*	*437*	856	0.493*
5.	Golden yellow ♂ x F_1♀ (greyish brown ♀ x golden yellow ♂)	..	*143*	*138*	281	0.089*
6.	Greyish brown ♀ x F_1♂ (greyish brown ♀ x golden yellow ♂)	*316*	..	*341*	657	0.951*

* Not significant.

ish brown larvae. The F_1 adults were inbred to obtain the F_2 generations. The results of crosses 5 and 6 (Table 5) fit the expected 3:1 ratio of brown and greyish brown larvae.

Similarly, when a cross was made between greyish brown and golden yellow, the F_1 larvae were all dark brown in color (Table 6). From crosses 1 and 2 it was obvious that the hybrids were intermediate in color expression. However, the results of back-crosses 3 and 4 fit a 1:1 ratio. The F_1 hybrids were inbred to F_2 generation. In the F_2 generation, the segregation of larval color was 1 golden yellow to 2 dark brown to 1 greyish brown (1:2:1).

DISCUSSION. When a cross was made between greyish brown and golden yellow the hybrids were intermediate in color. There were no mosquitoes which could be classified as being either pure greyish brown or golden yellow, all being dark brown in color. The F_1 heterozygotes which were inbred to a 2nd generation produced offspring with an approximate ratio of 1:2:1 (golden yellow: dark brown: greyish brown). When the dark brown F_1 heterozygotes were back-crossed to golden yellow homozygotes, the offspring were brown and golden yellow in a ratio approximating 1:1. Greyish brown and golden yellow therefore appear to be allelic, with intermediate expression in the heterozygous condition.

Similar results were obtained when a cross was made between green and yellow larvae of *Culex pipiens* (Laven 1957). In the F_1 generation all the hybrids were intermediate in color. There were no individuals which could be classified as pure green, all being light green. The back-crosses between the heterozygous insects and pure green larvae gave only 2 classes in an approximate ratio of 1:1, thus indicating that mutations yellow and green were most probably allelic with intermediate expression in the heterozygous condition.

In most of the remaining crosses green was found to be dominant over brown, greyish brown and golden yellow; and brown was dominant over golden yellow and greyish brown. Huff (1929), who was the first to conduct genetical analysis of a morphological trait of *Culex pipiens,* crossed green and brown larvae from one of his strains and found that brown was dominant over green and that in the 2nd generation the ratio of brown to green was almost precisely 3:1. Ghelelovitch (1950) made crosses between green and brown larvae of a different strain and found green dominant over brown, the reverse of the results obtained by Huff. In this case also the data indicated a monofactorial inheritance. At the present investigation, green and brown were isolated from the same strain (Bangalore). Craig and Gillham (1959) made a cross between the larval mutants, melanotic and yellow of *Aedes aegypti.* The F_1 progeny of such crosses were wild type and did not resemble either parent. The F_2 progeny, on the other hand, showed a segregation in good agreement with 1 melanotic to 2 wild type to 1 yellow. These results are consistent with the hypothesis that yellow and melanotic are allelic factors.

The fact that all the 4 mutants studied apparently belong to an allelic series is perhaps expected but these experimental results provide, for the first time, direct support for this assumption.

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